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THE EFFECT OF USING ARTIFICIAL INTELLIGENCE (AI) ON STUDENTS' CRITICAL THINKING SKILLS IN MAGNETIC ELECTRICITY COURSES

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Abstract

In today's digital era, AI (Artificial Intelligence) technology has developed rapidly and is being applied in various aspects of life, including education. This study aims to analyze the effect of AI use on students' critical thinking skills in the electromagnetism course for physics education students who have taken or are currently taking the electromagnetism course. This study employs a quantitative approach, utilizing descriptive analysis. The data collection instrument used in this survey research is a questionnaire. The sampling technique used is simple random sampling. The sample used in the study consisted of 10 respondents from each of the classes of 2021, 2022, and 2023, without any specific provisions or criteria in place. The results of the study indicate that students feel helped by the presence of AI in the learning process. AI technology provides instant solutions to problems and issues, and students can easily access and understand complex material. The findings of this study highlight the need to integrate AI in electromagnetism learning, a complex concept that requires high-level reasoning skills. Initial findings suggest that AI offers benefits, including personalized learning and the visualization of complex ideas, but also presents challenges in terms of teacher preparedness, student digital literacy, and potential technology dependency. Furthermore, students' low critical thinking skills in electromagnetism emphasize the need for pedagogical innovation. AI is seen as capable of supporting the development of critical thinking through simulations, adaptive assessments, and data-driven guidance. Therefore, empirical research is necessary to determine the extent to which the use of AI improves students' critical thinking skills.

Keywords: AI (Artificial Intelligence), Critical Thinking, Magnetic Electricity, Technology-based Learning, Physics Education

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INTRODUCTION

Technology has developed very rapidly in the current digital era. Artificial intelligence technology significantly changes various aspects of human life, including education. AI (artificial intelligence) is designed to enable a computer system to imitate human intellectual abilities. AI (artificial intelligence) involves algorithms that solve problems, and it is continually evolving, allowing it to be applied in various fields, including science (Supriyadi & Asih, 2021). In the world of education, AI (artificial intelligence) is used to assist the learning process of students and students (Trinovianti, 2023). One application of AI (artificial intelligence) in higher education is in courses that are abstract or require an in-depth understanding, such as courses on magnetic electricity.

Magnetic electricity is a course that studies the interaction between magnetic and electric fields (Amalia, 2017). This course relies on students' understanding of physics concepts and their ability to analyze various complex physical problems. In this case, critical thinking skills are essential for students to understand, critique, and apply the theory in solving problems (Nuryanti et al., 2018). However, with the rapid advancement of technology, the question arises of how AI (artificial intelligence) in higher education can affect students' critical thinking skills, especially in magnetic electricity courses (Pangkey et al., 2019).

Critical thinking ability refers to an individual's ability to evaluate information objectively, consider various points of view, and make rational decisions based on existing facts (Triwulandari, 2022). In higher education, critical thinking skills are one of the most important indicators in evaluating the learning process and achieving student competencies in science. Meanwhile, AI (Artificial Intelligence) can provide solutions or solve technical problems automatically, such as solving physics problems and abstract concepts, and can also provide material understanding (Saraswati et al., 2023).

However, the use of AI (artificial intelligence) in the context of learning in magnetic electricity courses can have a different impact on critical thinking skills for each student. AI (artificial intelligence) can accelerate the understanding of material and solve complex problems efficiently (Mardhani et al., 2022). However, concerns have been raised about the overuse of AI. Excessive use of AI (Artificial Intelligence) can reduce critical thinking and analyzing processes for each student, thus inhibiting students' ability to think critically (Kurniawati & Ekayanti, 2020).

The use of AI (artificial intelligence) in education can improve the efficiency and effectiveness of learning. AI (artificial intelligence) can provide knowledge that enables automatic feedback to students and facilitates teaching through virtual assistants or chatbots that can answer questions and solve student problems related to the course material (Maulani et al., 2024). In magnetic electricity courses, AI (artificial intelligence) can learn the material through simulation software that can help students theoretically visualize physics concepts that are difficult to understand (Abimanto & Mahendro, 2023).

However, the use of AI (artificial intelligence) technology also has its challenges, although AI (artificial intelligence) has the potential to improve the quality of learning. One of the main challenges of using AI (artificial intelligence) in magnetic electricity courses is that this technology can reduce active involvement in the critical thinking process. Using AI (artificial intelligence) in learning can cause students to become dependent on artificial intelligence technology. It can reduce student motivation to solve problems independently (without the help of AI) or to think critically (Abimanto & Mahendro, 2023). This concerns students using AI (artificial intelligence) to find quick answers without solving the problem in detail and understanding the underlying concepts (Kurniawan et al., 2021).

In addition, using AI (artificial intelligence) in learning can exacerbate the skills gap between students who are more familiar with technology and those with less access to or understanding (Abimanto & Mahendro, 2023). Several studies have revealed that overuse of technology can have a dual impact on students' critical thinking skills. On the one hand, AI (artificial intelligence) can help improve students' understanding of course materials by providing various information and visualization tools. For example, AI applications for practicum simulation can simulate electricity and magnetism experiments, allowing students to see firsthand how changes in certain variables affect experimental results. This can deepen concept understanding and improve students' analytical skills in theoretical and practical contexts (Haryani, 2017).

However, students who rely too much on AI to solve problems or answer questions may not engage in deep and critical thinking (Rochim, 2024). For example, suppose students use AI to solve physics problems in a magnetic electricity course without trying to figure out the solution steps themselves. In that case, they may not develop a deep understanding of the concepts involved (Yolanda, 2019). This can lead to students tending to think passively and rely on the result

provided by the AI without understanding the underlying process (Bimantara et al., 2024).

AI (artificial intelligence) must be integrated wisely in learning to improve students' critical thinking skills (Bimantara et al., 2024). AI should support learning in magnetic electricity, not as a substitute for active student interaction with the material. For example, AI can be used to provide automatic feedback on tasks done by students, enabling them to correct mistakes and understand concepts that are less mastered. However, students should still be encouraged to understand the steps of problem-solving in-depth and be trained to think critically when applying physics theories.

The use of AI (artificial intelligence) in education, particularly in magnetic electricity courses, offers a variety of potential benefits and challenges. While this technology can help accelerate understanding of the material and improve students' analytical skills, excessive use can also negatively impact students' critical thinking skills (Abdullah, 2016). Therefore, it is important to integrate AI (artificial intelligence) wisely in the learning process while considering the development of students' critical thinking skills. Through the right approach, AI (artificial intelligence) can be an effective tool to support learning without reducing the quality of students' intellectual engagement (Rochim, 2024).

THEORETICAL REVIEW

Critical Thinking

Critical thinking is an important cognitive skill in dealing with the development of science and technology in the modern era. Critical thinking is analyzing information, evaluating arguments, and drawing conclusions based on valid and systematic logic (Ajri & Perdana, 2023). This ability involves logical thinking and reflective and evaluative skills in viewing a problem. Critical thinking is a foundation in education that encourages students to solve problems, understand complex concepts, and build strong arguments (Ruhana et al., 2023). By thinking critically, students will be more open to questioning the information they receive, so they are not easily trapped in assumptions or invalid information. The importance of critical thinking becomes even more apparent when the material studied involves scientific concepts that require in-depth study, such as magnetic electricity material in physics, which relies on memorization and in-depth understanding to solve problems.

Furthermore, critical thinking encourages students to connect theory with real-life phenomena. In magnetic electricity material, for example, students learn about basic theories such as Faraday's law, magnetic fields, or Lorentz force and how these concepts are applied in modern technology such as dynamos, transformers, and electric motors (Ajri & Perdana, 2023). The critical thinking process allows students to develop analytical skills by dissecting the problem into small parts to find the most appropriate solution. This skill also encourages student creativity in finding new ways to understand concepts, conduct experiments, and design solutions to physics-based problems (Suprihartini & Taryana, 2023). Therefore, critical thinking is very important in education because it allows students to become independent, logical, and innovative thinkers in facing various increasingly complex learning challenges in the future.

Artificial Intelligence (AI)

Artificial intelligence (AI) is a field of computer science that focuses on developing systems or machines that mimic how humans think, such as understanding data, learning from experience, and automatically making decisions. Through this technology, students can see how magnetic field lines are formed, how changes in electric current can produce magnetic fields, and how electromagnetic induction works in various technological devices (Ariyanto et al.,m 2022). In addition, using AI in learning also allows for real-time analysis of student learning progress. AI systems can detect students' difficulties in understanding certain material and provide solutions through additional teaching or adjustments to learning methods. Thus, artificial intelligence is not just a supporting technology but also an innovation in education that can increase the effectiveness of the learning process and encourage a deeper understanding of concepts, including magnetic electricity material. (Permana, Widiyatmoko, and Taufiq 2016).

Understanding of Magnetic Electricity

Understanding magnetic electricity material is one of the important aspects of learning physics because it involves basic concepts that are the basis for the development of modern technology. This material discusses the interaction between electric current and magnetic field and its application in everyday life, such as electric motors, generators, transformers, and other electronic devices (Suseno, 2014). The concept of magnetic electricity includes physical laws such as Faraday's law of electromagnetic induction, Biot-Savart's law of magnetic fields, and the Lorentz force, which explains the effect of magnetic fields on electrically charged particles (Soraya, 2021). Understanding this material requires students to think logically, systematically, and critically about the causal relationship between electrical and magnetic phenomena. However, the challenges students face are often related to the abstract nature of the

material and are difficult to visualize directly. Therefore, a learning approach that combines theory, practical experiments, and technological support, such as computer-based simulations, is needed (Haqiqi et al., 2015).

Effective learning methods are instrumental in helping students understand magnetic electricity material in depth. One method that can be applied is a problem-based learning approach where students are invited to identify real problems related to magnetic electricity, analyze the causes, and design solutions using physics principles (Zaduqisti, 2010). In addition, digital technologies such as interactive simulations or AI-based modelling can clarify abstract concepts such as magnetic fields or electromagnetic induction so that students can see how these concepts work in real situations (Ariyanto et al., 2022). Laboratory practicum also plays an important role in strengthening student understanding because, through direct experiments, students can observe physical phenomena that occur, take measurements, and analyze data to prove the theories learned (Ika et al., 2021). With a comprehensive approach, understanding magnetic electricity material will help students master theory and develop critical thinking, analytical, and problem-solving skills that can be applied in everyday life and future technological developments.

METHOD

General Background

This research uses survey research according to Figure 1. Survey research is one of the quantitative research methods used to collect data from a group of individuals. This survey research aims to understand their characteristics, opinions, behavior, or experiences. This method involves collecting information through questionnaires, interviews, or observations. Survey research has several advantages. Namely, survey research can cover a wide population, is efficient in data collection, flexible in design, and the type of information that can be obtained. Researchers can obtain representative and relevant data when using a survey approach, making it possible to generalize to a larger population. This survey research aims to identify trends or patterns regarding using AI on magnetic electricity material in physics education students. Evaluating the relationship between variables related to the use of AI on magnetic electricity material significantly influences the ability to think critically about physics Education students. Researchers can develop or test hypotheses that have been compiled before taking data. Data will be provided for decision-making after the questionnaire has been given to respondents.

This study identified problems for phenomena physics education students in dealing with magnetic electricity lectures. After placing the issues, the researcher compiled a Google Form questionnaire. In collecting data, this study used a simple random sampling technique, where researchers took samples from three batches with 30 respondents. The respondents were 10 students from class 2021, 10 from class 2022, and 10 from class 2023. After collecting the data, the researcher analyzed the data from the questionnaire results, which already had the results. Then, the results that had been obtained were submitted or attached.

Participant

This study took research data using a simple random sampling technique. The simple random sampling technique is the taking of sample members from a population carried out randomly without regard to the strata in that population (Sugiyono, 2018). The Simple Random Sampling technique is a random sampling method in which each member of the population has the same opportunity to be selected. This technique is considered the simplest and most frequently used method in quantitative research. The process is done through lottery, random number tables, or special software (Triyono, 2003). The advantages of this technique are that it is free from bias because the selection is done randomly, the results are more representative, and it is easy to apply, especially in small populations. However, the disadvantages lie in the need for a complete sample frame, the difficulty of applying to large populations because it requires time and money, and the risk of results that do not reflect the population if the sample size is too small. This study took samples from three batches of physics education students who had taken or were taking magnetic electricity courses.

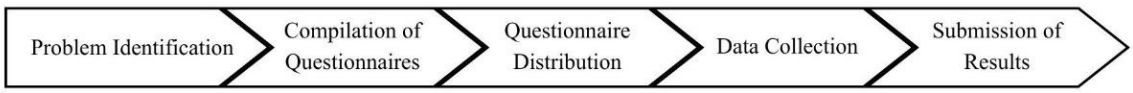

Figure 1. Research flowchart

A sample is a portion of the population selected to represent the population in research. Adequate sample size is crucial to generalizing the research results properly. Sample selection is based on population characteristics, research objectives, and sampling techniques (Astuti, 2017). Based on the method, samples are divided into two types: probability and non-probability samples. Probability samples allow each population element to have a known chance of being selected, such as in simple random sampling or stratified sampling.

In contrast, non-probability samples, such as purposive or convenience sampling, do not guarantee equal opportunities. Factors that determine sample size include population size, acceptable error rate, confidence level, and variability in population characteristics (Aziza et al., 2024). The samples used are the class of 2021 students, the class of 2022 students, and the class of 2023 students. The researcher took a sample of 10 randomly selected students from each batch without any specific criteria or characteristics.

Research Instruments

The instrument used in this study was a questionnaire. A questionnaire is a list of questions given to others willing to respond according to the user's request. The purpose of distributing questionnaires is to find complete information about a problem and respondents without worrying if the respondent provides answers that are not real in filling out the list of questions and the tools used to collect data in the form of a list of questions/statements made in the form of a questionnaire using a Likert scale (Syarifuddin, Bata Ilyas, and Sani 2021). A closed questionnaire is a questionnaire that is presented with several optional questions that respondents will later answer (Parnabhakti and Puspaningtyas 2021). The study used a questionnaire model with a Likert scale. Data collection is done by filling out the Google form given to respondents. The respondents must answer 20 questions using a Likert scale in the questionnaire. The Likert scale used, namely: "Strongly agree" is worth 5, "Agree" is worth 4, "Neutral" is worth 3, "Disagree" is worth 2, and "Strongly disagree" is worth 1.

Data Analysis Technique

The data analysis technique used is descriptive data analysis. Descriptive data analysis is a technique used to describe or summarize data systematically. This descriptive data analysis technique does not make generalizations or causal conclusions in the results and discussion. The descriptive data analysis technique is a method used to present data clearly and concisely, typically through tables, graphs, diagrams, or statistical measures such as average, median, mode, percentage, and standard deviation. This technique provides an initial overview of the data collected before further analysis (Sholikhah, 2016). The steps in descriptive analysis start from compiling data in the form of tables or frequency distributions, followed by calculating statistical measures such as central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation), to present data in visual forms such as bar charts or histograms.

The advantages of this technique are that it is easy to use, the results are informative, and it helps to understand data distribution patterns. However, this technique has limitations because it only describes data without being able to show cause-and-effect relationships between variables. These three components, simple random sampling, samples, and descriptive data analysis techniques, are interconnected in quantitative research. The sampling technique ensures a representative sample, which becomes the basis of research to represent the population. Descriptive analysis plays a role in describing the collected data to make it easier to understand.

RESULTS AND DISCUSSION

This study was conducted to investigate the impact of Artificial Intelligence (AI) on students' critical thinking skills in magnetic electricity courses. Based on data obtained from a questionnaire given to respondents, researchers found the extent to which AI influences students' critical thinking skills in magnetic electricity courses. The survey results regarding the effect of using AI on students' critical thinking skills are describe in Table 1.

Table 1. Survey results the effect of using AI on understanding magnetic electricity material

No.	Statement	Likert Scale				
		SD	DL	M	A	SA
1	The use of AI in the magnetic electricity course helped me understand the material more deeply.	0%	2.9%	32.4%	55.9%	8.8%
2	The AI lab simulation in Magnetic Electricity learning helps me understand difficult concepts more easily.	2.9%	2.9%	38.2%	52.9%	2.9%

No.	Statement	Likert Scale				
		SD	DL	M	A	SA
3	AI helped me organize complex information related to Magnetic Electricity.	0%	8.8%	50%	38.2%	2.9%
4	AI helped me connect the theory of Magnetic Electricity with its practical applications.	0%	2.9%	38.2%	52.9%	5.9%
5	I felt more prepared for the Magnetic Electricity exam after using AI.	2.9%	20.6%	44.1%	26.5%	5.9%

Survey results in the effect of using AI on understanding magnetic electricity material

This statement is prepared to determine the effect of using AI on understanding magnetic electricity material. Utilizing AI in magnetic electricity courses enables students to gain a deeper understanding of the material. Most respondents (64.7%) agreed or strongly agreed with the statement that AI helped them understand the material more deeply. This indicates that AI generally has a positive impact on understanding magnetic electricity materials. In addition, AI-based laboratory simulations are considered effective in learning difficult and complex concepts of magnetic electricity. 58.8% of respondents agreed or strongly agreed with the statement. However, it helps organize complex information. 8.8% of respondents felt less helped, indicating that some respondents may still struggle with optimization.

Although AI is considered useful in understanding magnetic electricity material for exam preparation, 32.4% of respondents are very well prepared for the magnetic electricity exam. This indicates that AI is effective in supporting understanding of the material. There is an improvement in helping students apply their knowledge in evaluative situations such as exams. Overall, the use of AI in learning magnetic electricity provides significant benefits, although it needs to be customized to meet individual needs more comprehensively.

Survey results on the effect of using AI on the ability to analyze and evaluate the concept of magnetic electricity

This statement is prepared to determine the effect of AI on the ability of physics education students to analyze and evaluate the concept of magnetic electricity (Table 2).

Table 2. Survey results on the effect of using AI on the ability to analyze and evaluate the concept of magnetic electricity

No.	Statement	Likert Scale				
		SD	DL	M	A	SA
1	AI helped me analyze the concept of magnetic electricity more critically.	0%	5.9%	32.4%	58.8%	2.9%
2	AI makes it easy for me to identify errors in problem-solving.	0%	2.9%	32.4%	58.8%	5.9%
3	AI helped me evaluate different arguments in the context of magnetic electricity.	0%	11.8%	47.1%	38.2%	2.9%
4	I am more capable of drawing logical conclusions after using AI in learning.	0%	11.8%	32.4%	47.1%	8.8%
5	The use of AI improved my ability to question assumptions in Magnetic Electricity.	0%	5.9%	47.1%	41.2%	5.9%

Most respondents rated the use of AI in analyzing and evaluating the concept of magnetic electricity positively. 61.7% agreed that AI helped them critically analyze concepts, although 32.4% felt moderately helped using AI. In addition, AI is considered to make it easier to identify errors in problem-solving, as many as 64.7% of students gave positive scores. This demonstrates that AI effectively analyzes concepts and enhances students' critical understanding of magnetic electricity materials.

On the other hand, the role of AI in helping evaluate arguments and draw logical conclusions also showed good results, although not as strong as its role in analysis. 47.1% of students found it helpful in evaluating arguments, while 56% agreed that AI helped them draw logical conclusions. However, AI's ability to improve assumption questioning skills received mixed scores. A total of 47.1% of students agreed with the statement. This data suggests that although AI is already effective in supporting the learning process, there is potential to enhance its functionality in evaluating and developing students' critical thinking skills.

Survey results in the effect of using AI on the ability to develop critical thinking skills

This statement was prepared to determine the effect of using AI on the ability to develop critical thinking skills (Table 3).

Table 3. Survey results on the effect of using AI on the ability to develop critical thinking skills

No.	Statement	Likert Scale				
		SD	DL	M	A	SA
1	Using AI encouraged me to reflect on my understanding of magnetic electricity.	0%	14.7%	47.1%	35.3%	2.9%
2	I ask critical questions more often after using AI in learning.	2.9%	14.7%	47.1%	29.4%	5.9%
3	Using AI laboratory simulations improved my skills in formulating hypotheses and drawing conclusions.	0%	5.9%	35.5%	55.9%	2.9%
4	I can develop critical questions related to magnetic electricity more easily after using the AI laboratory simulation	0%	5.9%	52.9%	38.2%	2.9%

Using AI to learn about magnetic electricity contributes positively to the development of students' critical thinking skills. 47.1% of respondents felt it helped them reflect on their understanding. Regarding asking critical questions, 47.1% of students said they do it often and are motivated to ask critical questions in learning magnetic electricity. However, 14.7% of students disagreed that AI encourages the development of reflection or critical questioning skills. This suggests a need to improve AI features or approaches in this aspect.

AI-based laboratory simulations are superior in helping students formulate hypotheses and draw conclusions. 58.8% of students agreed and strongly agreed with the statement. In addition, as many as 55.9% of students felt that it helped them develop critical questions related to magnetic electricity material after using AI simulations. However, as many as 5.9% of respondents felt that using AI helped them less. This suggests that the effectiveness of AI can be enhanced to cater to diverse learning needs. AI has great potential in developing students' critical thinking skills, although some areas still require further development.

Survey results in the effect of using AI on independence and confidence in learning

This statement was prepared to determine the effect of using AI on independence and confidence in learning (Table 4).

Table 4. Survey results on the effect of using AI on independence and confidence in learning

No.	Statement	Likert Scale				
		SD	DL	M	A	SA
1.	I feel more confident in analyzing Magnetic Electricity problems after using AI.	0%	11.8%	41.2%	47.1%	0%
2.	I feel that using AI makes me more independent when learning magnetic electricity.	2.9%	17.6%	41.2%	35.3%	2.9%
3.	The AI simulation allowed me to conduct experiments independently, which improved my critical thinking skills	5.9%	8.8%	44.1%	38.2%	2.9%

Using AI in learning Magnetism positively impacts students' independence and confidence. 47.1% of respondents felt confident analyzing problems after using AI, although another 41.2% felt moderately helped. No respondents were very confident, and 11.8% felt less confident. This suggests that while AI supports students' confidence, there is still room to improve its impact, especially for those who think it is less helped.

Regarding independence, around 38.2% of respondents agreed that AI made them more independent in learning, with another 41.2% finding it helpful. AI simulations also helped most respondents (44.1%) conduct experiments independently, which supported their critical thinking skills. However, 17.6% of respondents felt less helped in developing independence through AI, indicating that the implementation of *AI* could be customized to meet the needs of a wider range of students. AI effectively increases

autonomy and confidence; however, improved implementation strategies are still needed for optimal results.

Survey results in the effect of using AI on adding new insights and perspectives in learning magnetic electricity

This statement was prepared to determine the effect of using AI on adding new insights and perspectives in learning magnetic electricity (Table 5).

Table 5. Survey results Influence of using AI on adding new insights and perspectives in learning magnetic electricity

No.	Statement	Likert Scale				
		SD	DL	M	A	SA
1	The use of AI in the magnetic electricity course helped me understand the material more deeply.	0%	8.8%	26.5%	61.8%	2.9%
2	The AI lab simulation in Magnetic Electricity learning helps me understand difficult concepts more easily.	2.9%	14.7%	50%	29.4%	2.9%
3	AI helped me organize complex information related to Magnetic Electricity.	2.9%	5.9%	47.1%	38.2%	5.9%

The use of AI in learning magnetic electricity has been proven to broaden students' horizons in applying concepts in the real world. 64.7% of respondents agreed or strongly agreed that *AI* helped them understand the practical applications of magnetic electricity, while 26.5% felt moderately helped. However, 8.8% still did not feel this benefit, suggesting that while the impact of AI is generally positive, some students require additional approaches or features to maximize their understanding.

Additionally, AI contributes to the development of critical thinking skills and the acceptance of new perspectives in learning. 32.3% of respondents strongly or moderately agreed that AI helped their overall critical thinking skills, while 47.1% felt it helped them be more open to new perspectives. However, around 14.7% still felt that the impact on critical thinking was less, and 5.9% held similar views on new perspectives. This data shows that while AI effectively adds insights and perspectives, there is still room to refine the design of *AI-based* learning to be more inclusive and adaptive to individual needs.

The use of artificial intelligence (AI) in learning magnetic electricity has significantly contributed to students' understanding of applying concepts in the real world (Rifky, 2024). AI allows students to understand electromagnetic phenomena practically through simulation and visualization. This helps them relate the theories learned in class to real implementations in various fields, such as energy technology and electronic devices (Ariyanto et al., 2022). However, some students still find the experience unhelpful, which suggests the need to develop AI features that are more personalized and relevant to their individual learning needs.

In addition to providing an understanding of practical applications, AI also supports the development of students' critical thinking skills. Using analysis algorithms, AI can help students evaluate complex concepts and identify errors in problem-solving (Zahra Salsabilla et al., 2023). This ability strengthens their understanding and encourages students to think more deeply about fundamental concepts in magnetic electricity (Surya & Prasetyo, 2020; Khusniyah, 2023). However, this effectiveness is not felt by all students, so there is a need to refine the approach used in AI-based learning.

AI also increases students' openness to new perspectives. By providing various simulations and learning scenarios, AI helps students see concepts from different perspectives (Salsabilla et al., 2023). This approach makes them more flexible in accepting new ideas and more critical in evaluating arguments. However, some students still felt that this impact was insignificant, indicating that AI should focus more on interactive learning that directly challenges critical thinking (Ariyanto et al., 2022)

In terms of developing critical thinking skills, AI provides innovative learning experiences through laboratory simulations. Students can interact directly with various digital experiments that allow them to formulate hypotheses and draw conclusions independently (Permana et al., 2016). This creates a dynamic learning environment and encourages students to be more independent in exploring the concepts taught (Susanto, 2021; Surya & Prasetyo, 2020). However, some students feel less helped in this

aspect, which indicates the importance of additional guidance to maximize their learning experience.

The role of AI in helping students ask critical questions is also noteworthy. By providing an in-depth analysis of data and concepts, AI encourages students to ask more questions about the assumptions and generalizations used in learning (Abdullah, 2016). This indirectly improves their reflection skills on the material learned. However, some students still showed the need to be more involved in this process, especially through a more collaborative learning approach (Khusniyah, 2023).

In addition to improving analytical skills, AI also facilitates students in evaluating arguments and drawing logical conclusions. With the help of AI, students can understand more complex argumentation patterns and identify the strengths and weaknesses of a concept or theory (Salsabilla et al., 2023). However, this effectiveness is still variable, as some students feel that AI is not sufficiently helpful in developing in-depth evaluation skills (Ariyanto et al., 2022)

Overall, AI has proven its potential as an effective tool in learning Magnetic Electricity. The impact is seen not only in understanding the material but also in developing critical thinking skills and student independence (Rochim, 2024). Nonetheless, some areas, such as learning personalization and collaboration, still require improvement to ensure that the benefits of AI are felt equally by all students (Susanto, 2021; Khusniyah, 2023). By optimizing the design and implementation of AI, students can gain a deeper understanding of the concept of magnetic electricity and its applications.

Overall, the survey results of the questionnaire show that AI has a very positive impact on learning magnetic electricity. It can deepen understanding, improve critical thinking skills, and build student learning independence (Zein, 2023). However, some respondents doubt or disagree with certain aspects of the submitted statements. However, overall, AI is an effective learning technology that can enhance student learning experiences and help students overcome the challenges of understanding complex material related to magnetic electricity. (Ariyanto et al., 2022).

CONCLUSION

The results of research that has been conducted on the effect of using AI on students' critical thinking skills in magnetic electricity courses show that most students have a positive view regarding the use of AI in the world of education. AI helps students understand magnetic electricity material more deeply, analyze concepts critically, and increase confidence in solving problems contained in complex magnetic electricity courses. Some students who became respondents also felt the benefits of identifying issues and finding information related to magnetic electricity material. However, some students answered doubts regarding the effectiveness of AI in encouraging students to ask critical questions about magnetic electricity material. In the use of AI-based laboratory simulations, some students doubt the effectiveness of the use of AI laboratory simulations on improving students' critical thinking skills in magnetic electricity material. However, using AI to learn magnetic electricity improves students' critical thinking skills. However, further optimization is also needed to increase the effectiveness of using AI in learning magnetic electricity, which is more practical and interactive.

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